A MONOGRAPH OF THE FRESHWATER ENTOMOSTRACA OF NEW SOUTH WALES. Part iv. Phyllopoda.

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(Plates xxviii.-xxxii.)

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Introduction.

The first Phyllopod to be recorded in Australia was *Lepidurus viridis,* which Baird described in 1850 from a specimen collected in Tasmania. The next records are those of the Rev. R. L. King published in 1855; King, very briefly, described four species from New South Wales, some of which were not even figured. This lack of figures hampered later writers in their identification of the species and some synonymy resulted; in King's original manuscript, all of which was not published, there are detailed figures of all the species and from these the author has been able to decide some doubtful points of synonymy.

In 1860 and 1866 Baird described two species collected in South Australia, one of which was synonymous with his *Lepidurus viridis.*

Claus redescribed one of King's species in 1872 from immature specimens.

In 1876 Richters described a new species which he called *Branchipus australiensis* from Peak Downs, Queensland.

In 1877 Tate described a *Lepidurus* collected in South Australia which was also synonymous with *L. viridis.*

Four new species of Conchostraca from South Australia were described by Brady in 1886, one of which was synonymous with one of King's species.

In 1887 Sars described *Cyclestheria hislopi* (Baird) as the type of a new genus; the specimens had been hatched from dried mud collected at Rockhampton, Queensland.

Eight species of Phyllopoda were recorded in Whitelegge's list of the Invertebrate Fauna of Port Jackson and the neighbourhood, which was published in 1889.

In 1895 Spencer and Hall gave a preliminary description of *Apus australiensis* from Central Australia, and Sars published a paper describing five of the previously described species. This was a valuable contribution to the literature of Australian Phyllopoda, since it contained very detailed descriptions, biological observations and five plates.

In 1896 the Report of the Horn Expedition to Central Australia was published, in which Spencer and Hall described four new species and proposed the

new genus *Limnadopsis*. The same year Sars published three papers, one dealing with two Phyllopoda from Western Australia, the second describing two new species from Queensland and the third tracing the development of *Estheria packardi*.

In 1902 Sayce gave a complete catalogue of the Australian Phyllopoda that had been previously recorded; he described some of the older species in more detail and six new species; he also proposed two new genera, *Parartemia* and *Branchinella*.

The Phyllopoda collected by the South Australian Museum Expedition to Strzelecki and Cooper Creeks were dealt with by Chilton in 1917.

At the present time eighteen species have been recorded from South Australia, including Central Australia and the Northern Territory; eight species from Victoria; six from Queensland; four from Western Australia and one from Tasmania. The present paper deals with nineteen species collected in New South Wales; six of these are described as new and three others are recorded for the first time in the State, and one for the first time in Australia.

The author's thanks are due to Dr. C. Anderson for permission to examine the collection of Phyllopoda in the Australian Museum and to Mr. F. McNeill for his ever ready help in facilitating their study. The whereabouts of King's original manuscript was traced by Mr. G. M. Goldfinch and Professor Mackie kindly lent it to the author from the library of the Teachers' Training College.

The author is especially indebted to Sir Baldwin Spencer and Dr. C. Chilton for specimens collected in Central Australia; to Professor T. Harvey Johnston for a collection from the Burnett River, Queensland; to Professor L. Harrison for specimens collected in various parts of New South Wales and to Sir T. W. Edgeworth David for a sample of dried mud from which a specimen of *Artemia salina* was obtained.

The drawings for this paper were all prepared by Miss D. Harrison.

Type specimens of the new species have been deposited in the Australian Museum, Sydney.

The following lists give the species of Phyllopoda recorded from the different States.

New South Wales.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae.—Artemia salina* (Linn.) var. *arietina* Fischer.

Subfamily *Branchinectinae.—Branchinecta tenuis*, n.sp., *B. parooensis*, n.sp.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.—Branchinella australiensis* (Richters), *B. frondosa*, n.sp., *B. proboscida*, n.sp., *Branchinella eyrensis* Sayce. *Branchinella ornata* (Wolf).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Limnadopsis birchii* (Baird), *L. parvispinus*, n.sp., *Paralimnadia stanleyana* (King), *Eulimnadia sordida* (King), *Estheria packardi* Brady, *E. lutraria* Brady, *E. rubra*, n.sp.

Family LIMNETIDAE.—*Limnetis macleayana* King, *L. tatei* Brady.

Victoria.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.—Branchinella australiensis* (Richters).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia sordida* (King), *E. victoriensis* Sayce, *Estheria packardi* Brady.

Family LIMNETIDAE.—*Limnetis macleayana* King, *L. tatei* Brady.

South Australia.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird, *Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae.—Artemia salina* (Linn.) var. *arietina* Fischer.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.—Branchinella australiensis* (Richters), *B. eyrensis* Sayce.

Family BRANCHIPODIDAE.

Subfamily *Parartemiinae.—Parartemia zieziana* Sayce.

Family STREPTOCEPHALIDAE.—*Streptocephalus archeri* Sars.

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia dahli* Sars, *E. sordida* King, *Limnadopsis birchii* (Baird), *L. tatei* Spencer and Hall, *L. brunneus* Spencer and Hall, *Estheria packardi* Brady, *E. lutraria* Brady, *E. dictyon* Spencer and Hall.

Family LIMNETIDAE.—*Limnetis macleayana* King, *Limnetis tatei* Brady, *Limnetis eremia* Spencer and Hall.

Queensland.

NOTOSTRACA.

Family APODIDAE.—*Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family STREPTOCEPHALIDAE.—*Streptocephalus archeri* Sars.

Family CHIROCEPHALIDAE.

Subfamily *Branchinellinae.—Branchinella australiensis* (Richters).

CONCHOSTRACA.

Family LIMNADIIDAE.—*Eulimnadia dahli* Sars, *Cyclestheria hislopi* Sars.

Western Australia.

NOTOSTRACA.

Family APODIDAE.—*Apus australiensis* Spencer and Hall.

ANOSTRACA.

Family BRANCHINECTIDAE.

Subfamily *Artemiinae.—Artemia salina* (Linn.) var. *arietina* Fischer.

CONCHOSTRACA.

Family LIMNADIIDAE.—*Estheria elliptica* Sars, *E. sarsii* Sayce.

Tasmania.

NOTOSTRACA.

Family APODIDAE.—*Lepidurus viridis* Baird.

Classification.

The Phyllopoda are divided into three suborders, the Anostraca, Notostraca and Conchostraca, and this classification has been followed in the present paper. Some writers reject the term Phyllopoda and divide the subclass Branchiopoda into four orders; Anostraca, Notostraca, Conchostraca and Cladocera.

Key to the suborders of Phyllopoda.

A. Body elongated, devoid of a carapace .. .. *Anostraca.*
AA. Body with a well developed carapace.
B. Carapace in the form of a shield covering the dorsal part of the body. *Notostraca.*
BB. Carapace composed of two two lateral valves which enclose the body. *Conchostraca.*

Suborder **Notostraca.**

Carapace shield-shaped, covering the dorsal part of the body. Second antennae reduced or absent. Eyes sessile. Caudal filaments jointed.

This suborder comprises a single family, the *Apodidae,* which has a world-wide distribution.

Family APODIDAE.

Carapace broad, with a cervical furrow defining the head. A variable number of segments projecting beyond the carapace. Caudal filaments elongated. Males without special clasping organs.

This family comprises two genera, both of which are represented in New South Wales.

Key to the genera of the Apodidae.

A. Last caudal segment produced into a flattened outgrowth between the caudal filaments .. .. *Lepidurus.*
AA. Last caudal segment not produced .. .. *Apus.*

Genus Lepidurus Leach, 1816.

Carapace large, usually covering all the body except one or two segments. Last caudal segment produced into a flat paddle-shaped outgrowth, extending between the caudal filaments. About sixty-three pairs of legs, the first pair with comparatively short endites which scarcely project beyond the edge of the carapace. Species very variable; fifteen have been described, one of which occurs in New South Wales.

Lepidurus viridis Baird.

Baird, Proc. Zool. Soc. London, 1850.

Syn.—L. angasii Baird, *L. viridulus* Tate, *L. kirkii* Thomson, *L. compressus* Thomson.

A detailed description and numerous figures are given by Sars (Archiv. for Math. og Nat., 1895, p. 4, Pl. 1, figs. 1-19). This is a very variable species, especially in the comparative length of the carapace. Specimens from five different localities were examined at the Australian Museum and the following measurements obtained: 1. Specimens from Deniliquin had an average length of 38 mm. and the carapace left four segments uncovered. 2. A single specimen from Hay was 32 mm. long and had 10 segments exposed. 3. Two specimens from Tamworth, one 20 mm. long and the other 25 mm., the former had 6 exposed segments and the latter 4. 4. A specimen labelled N.S.W. was 15 mm.

long and had 10 segments exposed. 5. A specimen from Molong was 25 mm. long and only the caudal segment was exposed.

Two specimens collected at Holbrook measured only 6 mm. in length and were possibly immature, so that the species could not be identified with certainty. The specimens were remarkable: carapace very long, covering all the body and also the caudal prolongation; dorsal keel distinct, extending more than three-quarters the length of the body, produced backwards into a long spine; carapace also produced back into spines at each side, the margins between the spines bearing a series of strong denticles; caudal prolongation broad at the base, somewhat triangular in form, bearing well-marked spines.

Distribution.—N.S.W.: Sydney, Hay, Tamworth, Molong, Deniliquin, Holbrook (?), Hunter River. Victoria; South Australia; Tasmania; New Zealand.

Genus Apus Schaeffer, 1756.

Carapace usually comparatively shorter than in *Lepidurus*. Telson short, cylindrical, without any paddle-shaped outgrowth. Endites of the first pair of legs usually much longer than in *Lepidurus*.

Thirty different species have been described; one occurs in New South Wales.

The genera *Apus* and *Lepidurus* are very closely allied and it may be questioned whether they are distinct; the main difference is the presence or absence of a caudal outgrowth, but this in itself seems insufficient for the separation into two genera. The comparative length of the endites of the first pair of legs and the relative amount of body covered by the carapace are not good generic characters and vary greatly even in members of the one species.

Apus australiensis Spencer and Hall.

Victorian Naturalist, xi., 1895, p. 161; Horn Expedition to Central Australia, Part ii., Zoology, 1896, p. 231, figs. 1-3.

This is a very variable species; specimens from the same locality often varying greatly in their relative dimensions. In 1896 Sars (p. 5, Plate 1, figs. 1-6) described a specimen from Western Australia with the following measurements: Total length 13 mm., length of carapace 8.5 mm., median length of carapace 6.5 mm., width of carapace 5.8 mm., length of caudal filaments 7.4 mm., length of exposed portion of the body 6.4 mm., length of terminal caudal segment 0.7 mm. The most striking differences between these measurements and those of Spencer and Hall are: 1. the carapace is longer in proportion to the exposed part of the body instead of being of equal length; 2. the width of the carapace does not attain its median length instead of exceeding it. Measurements were made of nine mature specimens, collected at Broken Hill, for comparison with these two sets of figures and the following table shows the variations in comparative proportions. In eight specimens the width of the carapace was greater than its median length and in all nine specimens the length of the carapace was greater than the length of the exposed portion of the body.

This species also varies in the number of exposed segments, the armature of the posterior sinus of the carapace and of the caudal segment, and the presence or absence of serrations on the lateral margins of the carapace. These variations are well marked in specimens in the Australian Museum which have been collected from different localities:

Measurements of Specimens from Broken Hill.

Specimen	1	2	3	4	5	6	7	8	9
Total length	50	42	45	50	38	27	42	40	43
Length carapace	30	23	27	28	25	20	25	24	25
Median length carapace	22	20	22	24	21	16	20	20.5	21
Width carapace	26	25	25	25	21	20	26	24	26
Length exposed portion of the body	20	19	18	22	13	7	17	16	18
Length terminal caudal segment	3	2	2	2	2	1	2	2	1.5
Width of same	4	3.5	3.5	3	3	2	3	3	3.5
Length caudal filament	—	8	21	11	15	12	21	10	26

1. Specimen from the Namoi River at Narrabri. Total length 30 mm., carapace 4 mm. shorter than the exposed portion of the body; median length equalling the width; 32 exposed segments, of which 14 are limbless. Posterior sinus with over 30 small denticles. No serrations present on the lateral margin of the carapace.

2. Locality Ivanhoe. Total length 45 mm., carapace 5 mm. longer than the exposed portion; median length equal to the width; 28 exposed segments, 12 being limbless. Posterior sinus bearing 30 spines. Lateral margins of the carapace minutely serrated for half their length.

3. Locality Bourke. Total length 38 mm.; carapace 6 mm. shorter than the exposed portion; width exceeding the median length by 2 mm.; 28 exposed segments. Posterior sinus with 33 spines. Lateral margins of the carapace minutely serrated in the lower part. In one specimen, caudal segment devoid of spines; in a second, the segment with two central spines, one above the other; in a third specimen, the segment without central spines but with a small group on each side.

4. Locality Mossgiel. Total length 55 mm.; carapace and exposed portion of the body of equal length; width exceeding the median length by 7 mm.; 28 exposed segments, 12 being limbless. Posterior sinus with 37 spines; a few minute spines on each side of the carapace. Caudal segment with a group of three spines and a sensory bristle on each side, a row of three spines down the centre and a row on the posterior edge.

In the living animal the colours are very striking. The carapace is yellowish-brown with deeper brown markings and changing opalescent tints; the exposed portion is yellowish-green, the spines usually being dark brown; the legs are reddish-brown.

Distribution.—N.S.W.: Hunter River, Macquarie River, Mossgiel, Narrabri, Ivanhoe, Bourke, Nyngan, Broken Hill, Budda and Marra Stations (Darling River), Goorimpa (Paroo River). Queensland; Victoria; Central Australia; South Australia; Western Australia.

Suborder **Anostraca.**

Body elongated, without a carapace, more or less vermiform, composed of 11-19 limb-bearing segments and 8 or 9 limbless segments. Eyes stalked and movable. Antennules small, filiform. Antennae in the male modified for clasping. Daday de Dees in his excellent monograph of the Anostraca (1910) has divided the suborder into five families, two of which are represented in New South Wales. Daday de Dees' scheme of classification has been followed through-

out. For convenience the pedigerous portion of the body has been termed the "trunk" and the limbless portion the "abdomen."

Key to the Families of the Anostraca.

A. 17 or 19 trunk segments, antenna of the ♂ one-segmented .. .. *Polyartemiidae.*
AA. 11 trunk segments, antenna of the ♂ 2- or 3-segmented
B. Antenna of the ♂ 3-segmented .. .. *Streptocephalidae.*
BB. Antenna of the ♂ 2-segmented.
C. Basal segments of the male antennae joined, forming with the head a frontal clypeus .. .. *Branchipodidae.*
CC. Basal segments of the male antennae not joined or very slightly joined at the base.
D. Head, male, with forehead unarmed .. .. *Branchinectidae.*
DD. Head, male, with one or more frontal appendages .. .. *Chirocephalidae.*

Family BRANCHINECTIDAE.

Body of variable dimensions; trunk either equal to the length of the abdomen without the cercopods, slightly longer or much shorter. Trunk composed of 11 segments, abdomen of 8 or 9. Cercopods of varying length, either mobile, articulating with the last segment of the abdomen or immobile. Head of both male and female unarmed. Antennae of the male composed of two segments, apical segment flattened or falciform. Apical segment of the penis usually denticulate, rarely smooth.

Key to sub-families of the Branchinectidae.

A. Abdomen composed of 8 segments, apical segment of antennae in the male flattened .. .. *Artemiinae.*
AA. Abdomen composed of 9 segments, apical segment of antennae in the male often triangular, falciform .. .. *Branchinectinae.*

Subfamily ARTEMIINAE Daday de Dees.

Body slender. Abdomen composed of 8 segments, the last of which is longer than the preceding segments. Cercopods short, of diverse form and structure. Head in both sexes simply rounded. All legs of similar structure, with one leaf-like branch. Apical segment of the penis usually with a spinulose surface, unarmed at the apex. This subfamily includes two genera which are inhabitants of fresh, brackish and salt water. One genus is represented in New South Wales.

Genus ARTEMIA Leach, 1819.

Male antennae with the basal segments slightly joined at the base; apical segments flattened, elongated, with the apex pointed. Egg-sac short, heart-shaped. Species very variable. One species occurs in New South Wales.

ARTEMIA SALINA (Linnaeus) var. ARIETINA Fischer.

Syn.—Branchipus arietinus Grube, *Branchipus oudneyi* Liévin, *Artemia proxima* King, *Artemia australis* Sayce, *Artemia westraliensis* Sayce.

Artemia salina is a very variable species and its synonymy is accordingly somewhat confused. There are, however, four distinct varieties, and the three forms described from Australia are all comprised in the variety *arietina* Fischer. The first of these was described by King in 1855 (p. 70) as *Artemia proxima;* the description was very brief and the only figure published was that of the

fifth leg, so that its identification was uncertain. In King's original manuscript, however, there is a page of drawings which include figures of the whole animal and separate studies of its parts; these show that it is decidedly synonymous with *A. salina.* In 1902 (p. 229) Sayce described two forms under the names of *A. australis* and *A. westraliensis* which are also synonymous.

The variety is characterised by its immobile cercopods which are united with the last segment of the abdomen, their form is variable, they are usually flattened and leaf-like, they may be poorly supplied with apical setae or both apical and lateral setae may be numerous. The body is of variable dimensions, the length of the trunk may be greater or less than that of the abdomen; the last segment of the abdomen may be longer than the preceding segments or of equal length. Egg-sac variable.

Distribution.—King's specimens were collected in salt-pans at Newington, N.S.W. A single female specimen was bred from dried mud collected at Macumba, Central Australia. Sayce's specimens were obtained from Glenelg, South Australia and Murchison, Western Australia.

Europe; Asia; Africa; North America.

Subfamily BRANCHINECTINAE.

Body of varying dimensions, the trunk often not attaining the length of the abdomen without the cercopods. Abdomen composed of 9 segments, last segment much shorter than the preceding segments. Cercopods usually mobile, rarely immobile and joined to the last segment of the abdomen. Antennae of the male two-segmented, apical segment either falciform or branched. Head of both male and female, rounded, unarmed.

This subfamily includes three genera which live in fresh and salt water.

Key to genera of Branchinectinae.

A. Cercopods mobile, articulating with the last segment of the abdomen.
  B. Apical segments of the male antennae falciform, simple .. .. *Branchinecta.*
  BB. Apical segments of the male antennae branched .. .. *Artemiopsis.*
AA. Cercopods immobile, united with the last segment of the abdomen .. .. *Branchinectella.*

Genus BRANCHINECTA Verrill, 1869.

Body of varying dimensions, either slender or very robust. Trunk usually not as long as the abdomen without the cercopods. Abdomen composed of 9 segments, the last of which is often tapering, rarely of uniform breadth, always much shorter than the preceding segments. Cercopods mobile. Integument of the body smooth. Head rounded, unarmed. Antennules filiform, varying in length. Antennae in the male with the basal segments either unarmed or with tubercles and setae, apical segments usually falciform. Antennae in the female flattened. Egg-sac variable.

Key to species of Branchinecta.

A. Antennules reaching the end of the first segment of the antenna .. .. . *tenuis.*
AA. Antennules far exceeding the length of the whole antenna .. .. .. *parooensis.*

BRANCHINECTA TENUIS, n.sp. (Plate xxx., figs. 4-7.)

Male (Fig. 4). Body long and slender. Trunk slightly longer than the abdomen without the cercopods. All segments of the body with a smooth surface, unarmed, last segment of the abdomen very short, less than half the length of

the preceding segments. Cercopods (Fig. 6) very long, equalling the last five segments of the abdomen combined, broad at the base, tapering to the apex, both margins bearing long setae. Head rounded, unarmed. Antennules narrow, slender, reaching the end of the first segment of the antenna. Basal segment of the antenna (Fig. 5) broad, inner margin bearing three leaf-like projections, middle projection serrated; second segment curved back over the first, tapering towards the apex, inner margin bearing a double row of denticles. Eyes of moderate size. Legs (Fig. 7) all of similar structure. Length 12 mm.

Female. Similar to the male in general structure of the body. Antennules slender, not quite as long as the antennae. Antennae flattened, leaf-like, pointed at the apex, surface bearing scattered hairs. Egg-sac very long and slender. Colour of spirit specimens milky white.

Distribution.—N.S.W.: Dubbo.

Branchinecta parooensis, n.sp. (Plate xxxi.)

Male. Body very robust, trunk not quite as long as the abdomen without the cercopods. Segments smooth and polished, in places bearing very minute hairs. Last segment of the abdomen much shorter than the preceding segments, tapering slightly posteriorly. Cercopods equal in length to the last four segments combined, strongly built and densely fringed with setae on both margins. Head comparatively small, forehead rounded, no trace of any frontal process. Eye small. Antennules unusually long, extending to about the ninth trunk segment, strongly built, tapering gradually to the apex. Antennae composed of two segments, basal segment broad and bearing an outwardly directed process which is minutely spinulate; second segment curved, strongly built, margins bearing tiny spines. Legs of similar structure. Length 36 mm.

Female. Similar to the male in general build, slightly smaller. Antennae flattened, pointed at the apex.

Colour in living specimens, transparent, cercopods faintly tinged with pink. Spirit specimens opaque white.

Distribution.—Clay pans on Goorimpa Station, Paroo River.

Family CHIROCEPHALIDAE.

Body of varying dimensions, trunk either attaining the length of the abdomen without the cercopods or longer than it. Trunk composed of 11 segments, abdomen of nine, last segment of the abdomen shorter than the preceding ones. Cercopods mobile, articulating with the last segment of the abdomen, rarely joined. Head of the female rounded, unarmed, that of the male either unarmed or with frontal appendages of varying structure. Basal segments of male antennae variously armed or unarmed. Eleven pairs of legs, rarely dissimilar. Apical segment of the penis either spinulose or with a smooth surface and pointed apex. Daday de Dees divides this family into three subfamilies, one of which is represented in New South Wales.

Key to subfamilies of Chirocephalidae.

A. Apical segment of the penis smooth, pointed terminally.
  B. Antennae of the male with serrated appendages .. .. .. *Chirocephalinae.*
  BB. Antennae of the male lacking serrated appendages .. .. *Eubranchipodinae.*
AA. Apical segment of the penis spinulose .. .. *Branchinellinae.*

Subfamily BRANCHINELLINAE.

Body of varying dimensions. Trunk usually longer than the abdomen without the cercopods; abdomen of 9 segments, the last of which is always the shortest, segments usually cylindrical, sometimes flattened. Head of the male bearing an appendage of varying structure; head of the female usually unarmed. Antennae of the male with or without serriform appendages. Endopodites of all feet usually similar, structure of endopodites of the anterior pairs sometimes dissimilar. Last segment of the penis with a spinulose surface.

The members of this subfamily are inhabitants of both fresh and salt water. It includes five genera.

Key to genera of the subfamily Branchinellinae.

A. Antennae of the male provided with serriform appendages .. . *Branchinellites.*
AA. Antennae of the male devoid of serriform appendages.
B. Frontal appendage of the male stalked, simple, projecting from the middle of the forehead .. .. , *Eubranchinella.*
BB. Frontal appendage of the male stalked, divided into two, projecting from the middle of the forehead or from the vertex.
C. All segments of the abdomen flattened, cercopods joined forming a rounded keel .. .. *Thamnocephalus.*
CC. All segments of the abdomen cylindrical, cercopods always distinct.
D. Endopodites of all the legs of similar structure .. .. *Branchinella.*
DD. Endopodites of the two anterior pairs of legs of different structure from the succeeding pairs .. .. *Dendrocephalus.*

Genus Branchinella Sayce, 1902.

Body of varying size; segments of the trunk with a smooth surface; segments of the abdomen in the male sometimes pointed at the posterior angles. Cercopods mobile, their margins setose. Head of the male with a stalked frontal appendage of varying structure and length. Antenna of the male with the basal segments distinct, apical segments usually falciform and unarmed. Apical segment of the penis elongated, armed with denticles.

This genus appears closely related to both *Branchinellites* and *Dendrocephalus*. Five species occur in New South Wales.

Key to species of Branchinella.

A. Frontal appendage in the male not exceeding the length of the basal segment of the antenna .. .. *australiensis.*
AA. Frontal appendage far exceeding the length of the antennae.
B. Frontal appendage with numerous branches. .. .. *frondosa.*
BB. Frontal appendage biramous.
C. Second segment of the male antenna falciform.
D. Rami of the frontal appendage armed with spines .. .. .. *eyrensis.*
DD. Rami of the frontal appendage bearing rounded processes *ornata.*
CC. Second segment of the male antenna shaped like a foot .. *proboscida.*

Branchinella australiensis (Richters).

Branchipus australiensis Richters, Journal de Mus. Godeffroy, xii., p. 43.—*Branchinella australiensis* Sayce, 1902, p. 234, Plate xxx.

This species has not hitherto been recorded in New South Wales. A number of fine specimens of both males and females were obtained by Dr. W. Hull at

Wagga. It has also been collected in the Paroo River and on Tiltagoona Station in the Cobar district.

The species has been recorded from Queensland, Victoria, South Australia and Central Australia.

Branchinella eyrensis Sayce.

Proc. Roy. Soc. Vict., xv., 1902, p. 239, Plate xxxi.

A few specimens of this species were collected in water holes on Goorimpa Station on the Paroo River. It has not been recorded previously from New South Wales. The species was described from specimens collected in Central Australia.

Branchinella ornata (Wolf).

Branchinema ornata Wolf; *Branchinella ornata* Daday de Dees, 1910, p. 266, Fig. 40.

Male. Body graceful, trunk equal to the length of the abdomen without the cercopods or a little longer. Last segment of the abdomen very much shorter than the preceding segments, produced between the cercopods. Cercopods tapering at the apex, comparatively short, about equal to the combined length of the last two abdominal segments, margins with long setae. Vertical appendage of the head with a flattened stalk, dividing into two at about half its length; branches of the appendage bearing several rounded processes on both inner and outer margins, otherwise unarmed. Antennules comparatively long, considerably exceeding the length of the basal segment of the antennae. Antennae unarmed except for two small tubercles on the basal segment; apical segment falciform, inwardly curved, pointed at the apex. Feet all of similar structure. Length, 12 mm.

Female. Body very similar to the male. Antennules very much longer than the antennae. Antennae flattened, leaf-like, pointed at the apex, setose. Egg-sac fusiform, extending the length of the first three segments of the abdomen.

Distribution.—This species has not hitherto been recorded in Australia. Specimens were collected on Tiltagoona Station in the Cobar district. It has only previously been recorded from Africa.

Branchinella frondosa, n.sp. (Plate xxviii.; Pl. xxix., figs. 1-4.)

Male (Fig. 1). Body robust, length of the trunk far surpassing that of the abdomen without the cercopods. Surface of the segments of both trunk and abdomen smooth and polished. Last segment of the abdomen about half the length of the preceding segment, slightly produced between the cercopods. Cercopods (Fig. 4) tapering towards the apex, directed towards each other; length almost attaining the combined length of the last four abdominal segments, setae long. Head (Fig. 3) comparatively large, rounded, a strong complicated appendage proceeding from the vertex; processes near the base very small and inconspicuous. Vertical appendage (Fig. 2) stalked and flattened basally; the basal portion narrowing at each end and broad in the middle; two main branches spring from this basal portion and these at once divide again into (1) one strong branch on the inside which remains undivided, (2) a strong branch which divides into three and these again bear smaller lateral branches, (3) a branch which bears lateral branches towards the apex. The whole structure has a tree-like appearance and extends as far as the fifth segment of the trunk, the surface

of the basal portion and the branches has a wrinkled appearance; the branches are provided with straight and curved spines. Antennules small, filiform, not attaining the length of the first segment of the antennae. Antennae (Fig. 3) composed of two segments, apical segment strongly curved and provided with a row of strong denticles. Exopodites of all the legs of similar structure (Fig. 5). Penis (Fig. 6) composed of two segments, the first very short, the second elongated, provided with a series of strong curved denticles along the sides. Length, 18 mm. Colour when alive transparent, cercopods a vivid orange-colour, of spirit specimens milky white.

Female (Plate xxix., fig. 1). Similar to the male in general structure. Antennae (Fig. 2) flattened and leaf-like, produced apically into a narrow point. Egg-sac (Figs. 3 and 4) strongly built, seen laterally, triangular, tapering at the apex, with a protruding lip. Length, 20 mm.

This species greatly resembles the genus *Dendrocephalus* in the form of its frontal appendage, but in every other respect it appears to be a true *Branchinella,* the exopodites of the legs all being of similar structure and the male antennae devoid of appendages. It is this species that is referred to in Whitelegge's list (1889, p. 318) as *Chirocephalus* sp.

Distribution.—N.S.W.: Yass.

Branchinella proboscida, n.sp. (Plate xxix., figs. 5-9; Pl. xxx., figs. 1-3.)

Male (Fig. 5). Body moderately robust; trunk almost equal to the length of the abdomen without the cercopods; all the segments with a smooth polished surface; last segment of the abdomen shorter than the preceding segments, not produced between the cercopods. Cercopods (Fig. 6) long, tapering towards the produced apex; equal in length to the four preceding segments combined, setae on the margins very long and delicate. Head of moderate size, bearing an elongated, segmented appendage which branches terminally and which almost reaches the end of the abdomen; this appendage can be coiled up and, when in this position, does not reach the end of the antenna; it is composed of about twenty segments before the bifurcation, the two branches of the latter broaden in the centre and taper apically; they are covered with small hairs and bear several rows of spines along the inner edges. Antennules filiform, slightly exceeding the length of the first segment of the antennae. Antennae (Fig. 9) of very unusual structure for the genus, first segment broad and without appendages, apical segment shaped somewhat like a foot, the margins of the apical portion finely serrated. Penis (Fig. 7) with an elongated apical segment, rounded at the apex and bearing rows of strong spines. Length, 14 mm. Colour similar to that of the preceding species.

Female (Fig. 1). Similar in size and general structure to the male. Antennae (Fig. 2) flattened, leaf-like, produced to a narrow projection apically. Egg-sac (Fig. 3) comparatively long and narrow, extending the length of four segments, deeply lobed at the apex.

Distribution.—N.S.W.: Dubbo, Marra and Budda Stations (Darling River).

Suborder **Conchostraca.**

Body enclosed by a bivalved carapace. Eyes sessile, either coalescent or closely contiguous. Antennules small. Antennae large, used as organs of locomotion. One or two pairs of legs in the male modified as clasping organs. Tail piece compressed, usually armed with spines.

Key to families of Conchostraca.

A. Carapace with concentric lines of growth round a more or less prominent umbo .. .. *Limnadiidae.*
AA. Carapace spheroidal, without lines of growth .. .. *Limnetidae.*

Family LIMNADIIDAE.

Carapace compressed, with a varying number of lines of growth. Head of medium size, showing little difference in the two sexes. Tail-piece well developed, forming two lamellae with varying armature. Legs numerous, endites short; first and second pairs in the male usually prehensile.

Five genera occur in New South Wales.

Key to genera of Limnadiidae.

A. Dorsal organ present.
  B. 26-32 pairs of legs; dorsal margin of the carapace with spiny processes. *Limnadopsis.*
  BB. About 18 pairs of legs, no spiny processes on the dorsal margin of the carapace.
    C. Umbones inconspicuous or absent, few lines of growth .. . *Eulimnadia.*
    CC. Umbones large and prominent, numerous lines of growth *Paralimnadia.*
AA. Dorsal organ absent.
  B. First pair of legs only prehensile in the male; antennules simple .. .. *Cyclestheria.*
  BB. First two pairs of legs prehensile in the male; antennules lobed . *Estheria.*

Genus LIMNADOPSIS Spencer and Hall, 1896.

Carapace ovate, compressed, narrower in the male than in the female; valves thin and like parchment. Lines of growth distinct, prolonged dorsally to form a series of spines on the dorsal margin of the carapace. Dorsal organ present. 26-32 pairs of legs, first two pairs prehensile in the male.

Key to species of Limnadopsis.

A. 30 or more pairs of legs present.
  B. Tail-piece armed with about fifty spines .. .. *squirei.*
  BB. Tail-piece with not more than eighteen spines .. .. *parvispinus.*
AA. 26 pairs of legs.
  B. Tail-piece with few spines of various sizes, carapace pitted .. .. *tatei.*
  BB. Tail-piece with small spines of uniform size, carapace pustulate . *brunneus.*

LIMNADOPSIS BIRCHII (Baird).

Estheria birchii Baird, Proc. Zool. Soc. London, 1860, p. 392.—*Limnadopsis squirei* Spencer and Hall, 1896, p. 239, figs. 15-19.

Distribution.—N.S.W.: Namoi River, Broken Hill. South Australia; Central Australia.

LIMNADOPSIS PARVISPINUS, n.sp. (Plate xxxii., figs. 1-7.)

Male (Fig. 1). Carapace irregularly oval in outline, moderately compressed; dorsal margin forming almost a right angle with the anterior margin and an obtuse angle with the posterior margin; anterior margin straight, ventral margin evenly curved; dorsal margin depressed before the umbo, curving convexly im-

mediately after the umbo. 12-14 well marked lines of growth; the carapace valves between the lines of growth smooth and polished. Processes on the dorsal margin of the carapace (Fig. 7) small and inconspicuous, 5 or 6 present in the posterior portion. Head of moderate size (Fig. 3), rostrum long and triangular. Antennules equal in length to the basal segment of the antennae. About thirty pairs of legs; first two pairs (Fig. 4) very much modified to form clasping organs. Tail-piece (Fig. 2) strongly built, end-claws longer than the lamellae, provided with a series of spines along three-quarters of their length, the remaining portion being provided with hairs; free margins of the lamellae curved, bearing about eighteen spines of uniform size and a larger spine at each end. Length, 16 mm. Colour yellowish-green, transparent.

Female (Fig. 5) slightly different from the male in the general shape of the carapace, the height being greater in proportion to the length; dorsal margin more evenly curved from the convexity behind the umbo to the posterior angle. Head larger than the male, but possessing a shorter and less conspicuous rostrum. Antennule shorter than in the male, not reaching the end of the basal segment of the antennae. Legs as in the male except that the first two pairs are not modified for clasping. Tail-piece (Fig. 6) with the free margins less curved than in the male and the end-claws not so strongly armed.

Distribution.—N.S.W.: Lake Cowal (Bland district), Mossgiel.

Genus Paralimnadia Sars, 1896.

Shell compressed, valves thin; lines of growth inconspicuous, very numerous; umbones large and prominent. Propagation sexual.

This genus was suggested by Sars in 1896 for the species known as *Eulimnadia stanleyana* (King). It is closely allied to both *Limnadia* and *Eulimnadia*.

Paralimnadia stanleyana (King).

Limnadia stanleyana King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.—*Eulimnadia stanleyana* Sars, 1895, p. 16, Plate 2, figs. 1-12, Plate 3, figs. 1-10.

Distribution.—N.S.W.: Coogee, Maroubra, Bondi.

Genus Eulimnadia Packard, 1873.

Carapace narrowly oval in lateral view, usually only 4 or 5 lines of growth. Flagella of the second antennae 9—10-segmented. 18-20 pairs of legs.

Eulimnadia sordida (King).

Limnadia sordida King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.—*Eulimnadia rivolensis* Brady, Proc. Zool. Soc. London, 1886, p. 87, fig. D.

This species was very briefly described by King and since he did not publish any figures, it was difficult to identify. Sars (1895, p. 17) suggested it might be synonymous with *Paralimnadia stanleyana,* while Sayce (1902, p. 245) considered that it was probably the same form as that described by Brady (1886, p. 87) as *Eulimnadia rivolensis.* The original specimen described is figured in King's manuscript and the drawings show without doubt that Sayce's opinion was correct. A detailed description of this species is given by Sayce (1902, p. 245, Plate xxxii.) under the name of *Eulimnadia rivolensis* Brady.

Distribution.—N.S.W.: Botany Bay, Moore Park, Nelson's Bay, Myall Lakes, Lismore. Victoria; South Australia; Central Australia.

Genus Estheria Rüppell, 1857.

Carapace oval, 10-22 lines of growth usually very distinct. Dorsal organ absent. 24-28 pairs of legs. Six species are described from Australia, three of which occur in New South Wales.

Key to species of Estheria.

A. Tail-piece bearing numerous anal denticles.
  B. More than 20 lines of growth . . . . . *packardi.*
  BB. Less than 20 lines of growth.
    C. Marginal area of the carapace with crowded concentric striae . *elliptica.*
    CC. Marginal area without any striae . . . . . *rubra.*
AA. Tail-piece with few (less than ten) anal denticles.
  B. Dorsal margin forming a distinct angle with the posterior margin . . . *sarsii.*
  BB. Dorsal margin joining the posterior without any angle.
    C. Eyes confluent . . . . . *lutraria.*
    CC. Eyes separate . . . . . *dictyon.*

Estheria packardi Brady.

Brady, Proc. Zool. Soc. London, 1886, p. 85, fig. C.

This appears to be the commonest species of *Estheria* in Australia, and usually occurs in large numbers. An account of its development was given by Sars in 1896 and a detailed description of the adult form in 1895 (p. 28, Plate 4. figs. 1-9, Plate 5, figs. 1-9).

Distribution.—N.S.W.: Botany, Hay, Dubbo, Trangie. South Australia; Central Australia; Victoria; Queensland.

Estheria lutraria Brady.

Proc. Zool. Soc. London, 1886, p. 85, fig. B.

Estheria lutraria is the largest species of the genus that occurs in Australia; it has not hitherto been recorded in New South Wales.

Specific characters. Carapace, seen laterally, with a very straight dorsal margin which meets the curved posterior margin without any definite angle. Umbo small and pointed, situated very close to the anterior end, dorsal margin sloping very obliquely from the umbo to the posterior end. Anterior margin much broader than the posterior. Surface of the carapace with an average of fourteen lines of growth, distinctly marked and bearing small hairs; surface between the lines marked with an irregular reticulation. Tail-piece comparatively short, dorsal margins of the lamellae deeply concave, about five small denticles; end-claws bearing feathered setae along half their length. Length of fully grown specimens attaining 14 mm.

Distribution.—N.S.W.: Dubbo, Broken Hill. South Australia; Central Australia.

Estheria rubra, n.sp. (Plate xxxii., Figs. 8-9.)

Carapace (Fig. 8), seen laterally, irregularly oval in outline; dorsal margin forming a distinct obtuse angle with the posterior margin; anterior margin

broadly rounded; posterior margin curved, narrower than the anterior. Umbones very prominent, situated fairly far forward. Seen from above not very tumid, greatest width occurring considerably in front of the middle, anterior end broader than the posterior. Surface of the carapace marked by about 12 distinct lines of growth which are provided with short bristles; between the lines the surface is marked by an irregular reticulation, no concentric striae on the outer margin. Dorsal margin bearing two or three small spines. Valves of firm consistency and moderately thick. Head comparatively large, eyes confluent, situated behind a somewhat round projection of the head. Last segments of the trunk with well marked spines, situated on small projections. Tail-piece (Fig. 9) well developed. a strong pair of denticles and two smaller pairs occurring in front of the caudal setae; dorsal margin curved, bearing a total number of 18-20 pairs of denticles, last pair very large; end-claws strong, bearing feathered setae along half their length and very small hairs or bristles along the remaining half. Colour of living specimens bright red to reddish-brown. Length, 6 mm.

Distribution.—N.S.W.: Marra and Budda Stations on the Darling River and Goorimpa Station on the Paroo.

Family LIMNETIDAE.

Carapace spheroidal, without lines of growth. Head large, not included in the carapace. First pair of legs prehensile in the male. Tail-piece undeveloped. Only one genus, *Limnetis*.

Genus Limnetis Lovén.

Carapace without umbones; surface smooth. Head produced into a large rostrum. Tail-piece unarmed.

Two species occur in New South Wales.

Key to species of Limnetis.

A. Rostrum in the female broadly rounded .. .. *macleayana.*
AA. Rostrum in the female narrow, long, notched at each side .. .. *tatei.*

Limnetis macleayana King.

Proc. Roy. Soc. Van Diemen's Land, 1855, p. 70.

Female. Carapace, seen laterally, of irregularly rounded shape, the greatest height not as long as the length and occurring in front of the middle. Seen from above, oval with the greatest width in the middle; anterior and posterior ends pointed, and of equal width. Rostrum very broad and obtusely rounded at the end. Eyes of moderate size, ocellus almost as large as the eyes. Twelve pairs of legs diminishing in size posteriorly. Tail-piece very small, ending in two rounded lobes, each of which bears a tiny spinule. Colour in the living animal, jade green. Length up to 7.5 mm.

Male. Very like the female in general form, except that the posterior end is narrower. Rostrum shorter than that of the female and transversely truncated at the tip. Ten pairs of legs, the first of which are modified as grasping organs.

Distribution.—N.S.W.: Botany, Liverpool, Denham Court, Hay, Myall Lakes, Paroo River. It has also been recorded from Victoria.

Limnetis tatei Brady.

Proc. Zool. Soc. London, 1886, p. 84.

Female. Carapace, seen laterally, rounded, greatest height occurring considerably in front of the middle. Seen from above oval, the greatest width be-

ing in the middle. Head comparatively larger than in the preceding species, rostrum produced, seen laterally, pointed at the apex; seen from in front, obtuse at the apex and with a well defined notch at each side. Legs similar to those of the preceding species. Colour in living specimens yellowish-green. Length up to 3 mm.

Male. Rostrum elongated, transversely truncated at the apex, the terminal edge bearing a fringe of cilia.

This species is more rarely found than the preceding one but is usually in large numbers when it occurs.

Distribution.—N.S.W.: Sydney, Botany, Maroubra. Victoria; South Australia.

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EXPLANATION OF PLATES XXVIII.-XXXII.

Plate xxviii.

Branchinella frondosa ♂.

Fig. 1.—Lateral view (x 15); Fig. 2.—Frontal appendage (x 28); Fig. 3.—Head (x 20); Fig. 4.—Cercopods (x 20); Fig. 5.—First leg (x 100); Fig. 6.—Penis (x 100).

Plate xxix.

Figs. 1-4 *Branchinella frondosa* ♀.

Fig. 1.—Head (x 30); Fig. 2.—Antenna (x 35); Fig. 3.—Egg-sac (x 30); Fig. 4.—Egg-sac, lateral view (x 30).

Figs. 5-9 *Branchinella proboscida* ♂.

Fig. 5.—Lateral view (x 15); Fig. 6.—Cercopods (x 30); Fig. 7.—Penis (x 60); Fig. 8.—First leg (x 150); Fig. 9.—Antenna (x 60).

Plate xxx.

Figs. 1-3 *Branchinella proboscida* ♀.

Fig. 1.—Head (x 15); Fig. 2.—Antenna (x 30); Fig. 3.—Egg-sac (x 30).

Figs. 4-7 *Branchinecta tenuis* ♂.

Fig. 4.—Lateral view (x 10); Fig. 5.—Antenna (x 15); Fig. 6.—Cercopods (x 15); Fig. 7.—First leg (x 150).

Plate xxxi.

Branchinecta parooensis ♂.

Fig. 1.—Lateral view (x 5); Fig. 2.—Antenna (x 7); Fig. 3.—Cercopods (x 10); Fig. 4.—First leg (x 20).

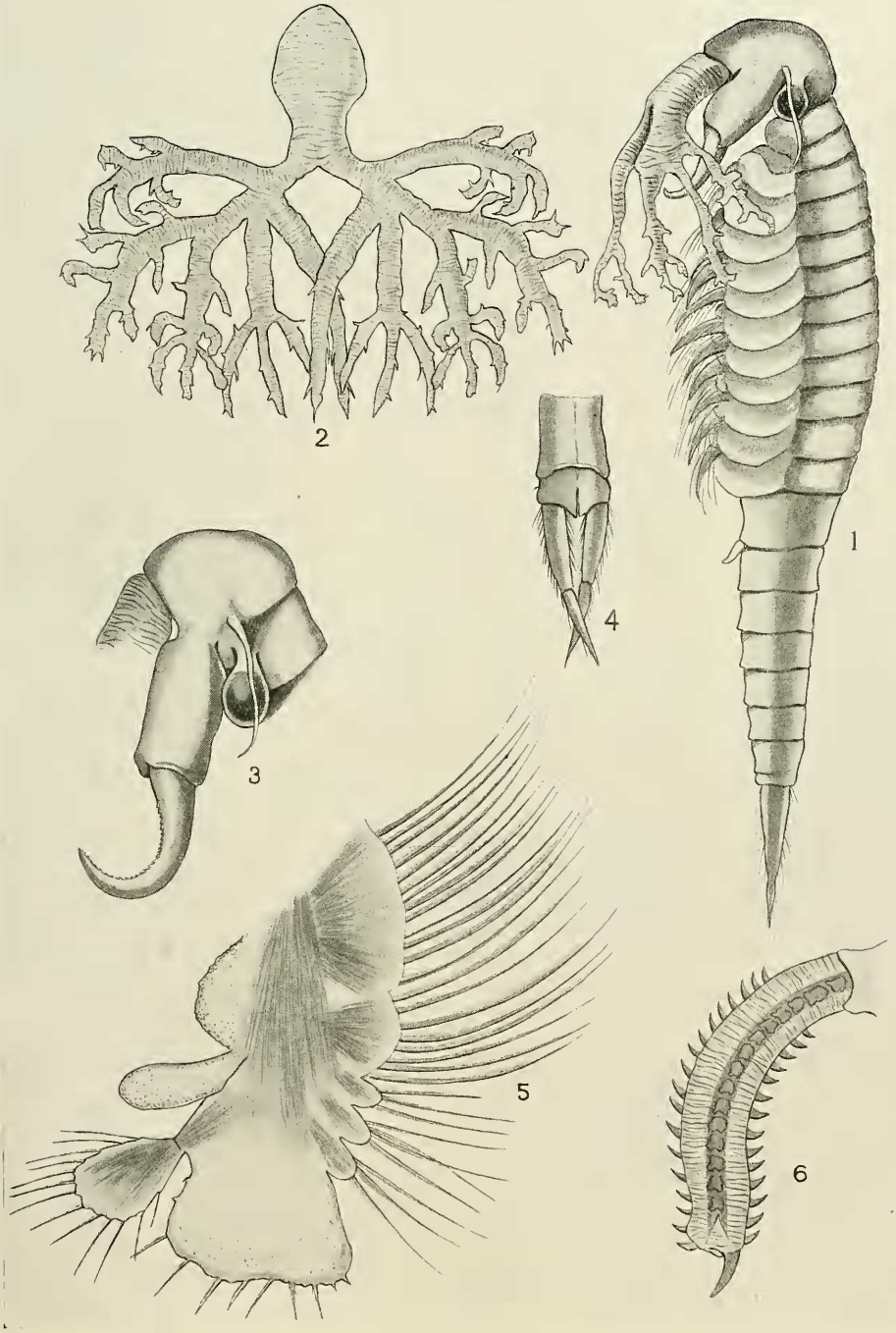
Plate xxxii.

Figs. 1-7 *Limnadopsis parvispinus*.

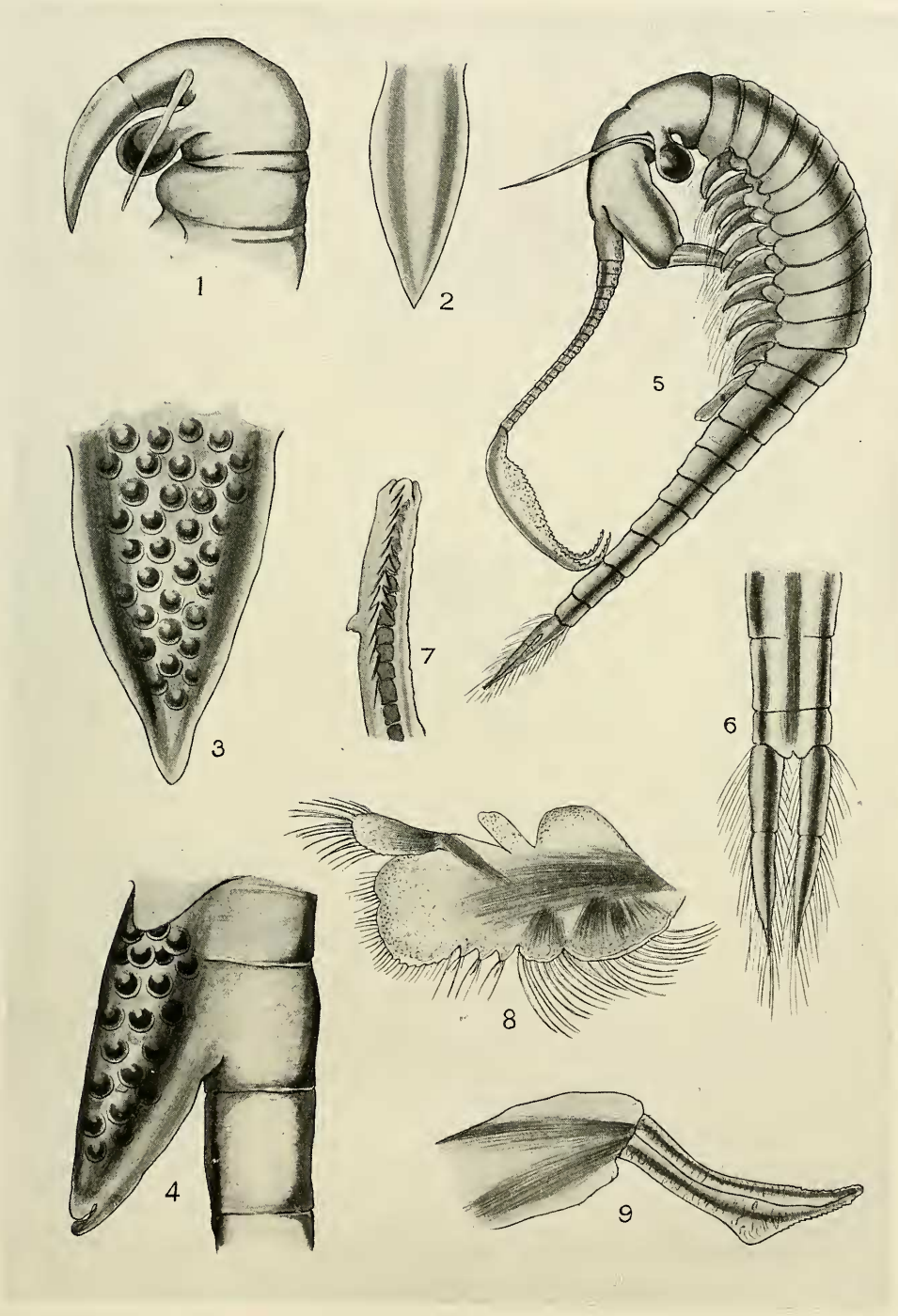
Fig. 1.—Lateral view ♂ (x 3); Fig. 2.—Tail-piece ♂ (x 9); Fig. 3.—Head ♂ (x 9); Fig. 4.—Modified leg ♂ (x 12); Fig. 5.—Lateral view ♀ (x 3); Fig. 6.—Tail-piece ♀ (x 9); Fig. 7.—Dorsal margin (x 7).

Figs. 8-9 *Estheria rubra*.

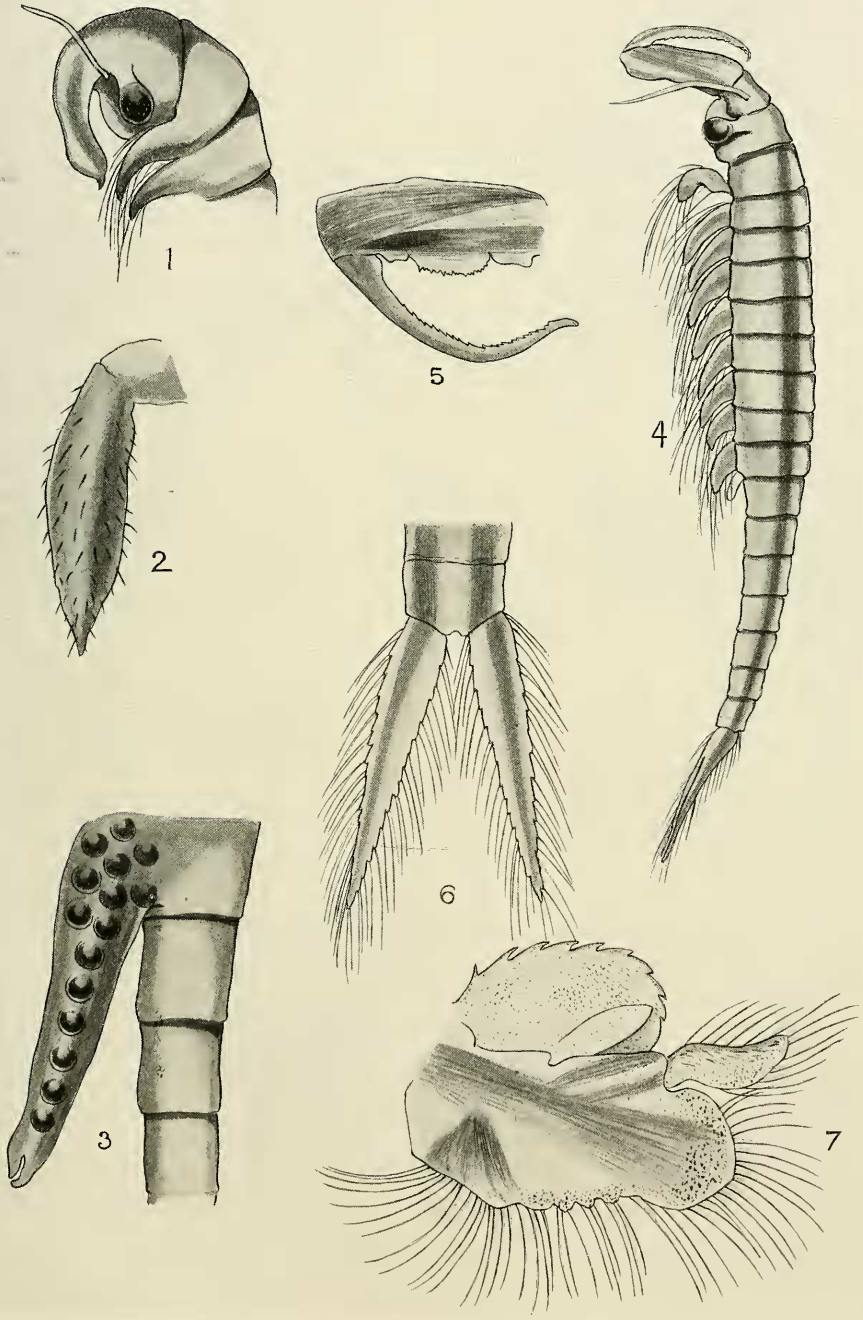
Fig. 8.—Lateral view (x 10); Fig. 9.—Tail-piece (x 25).



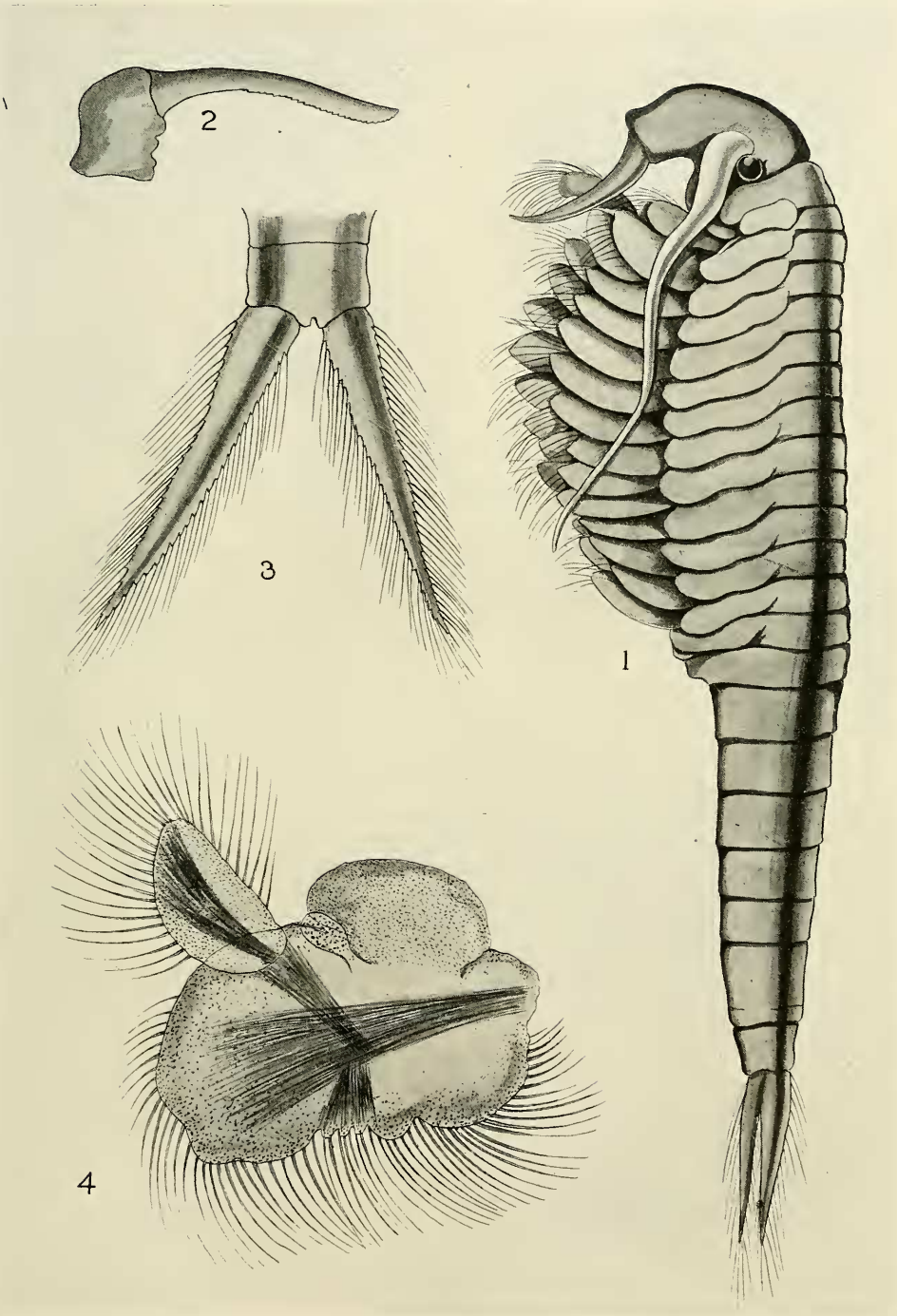
Branchinella frondosa ♂.



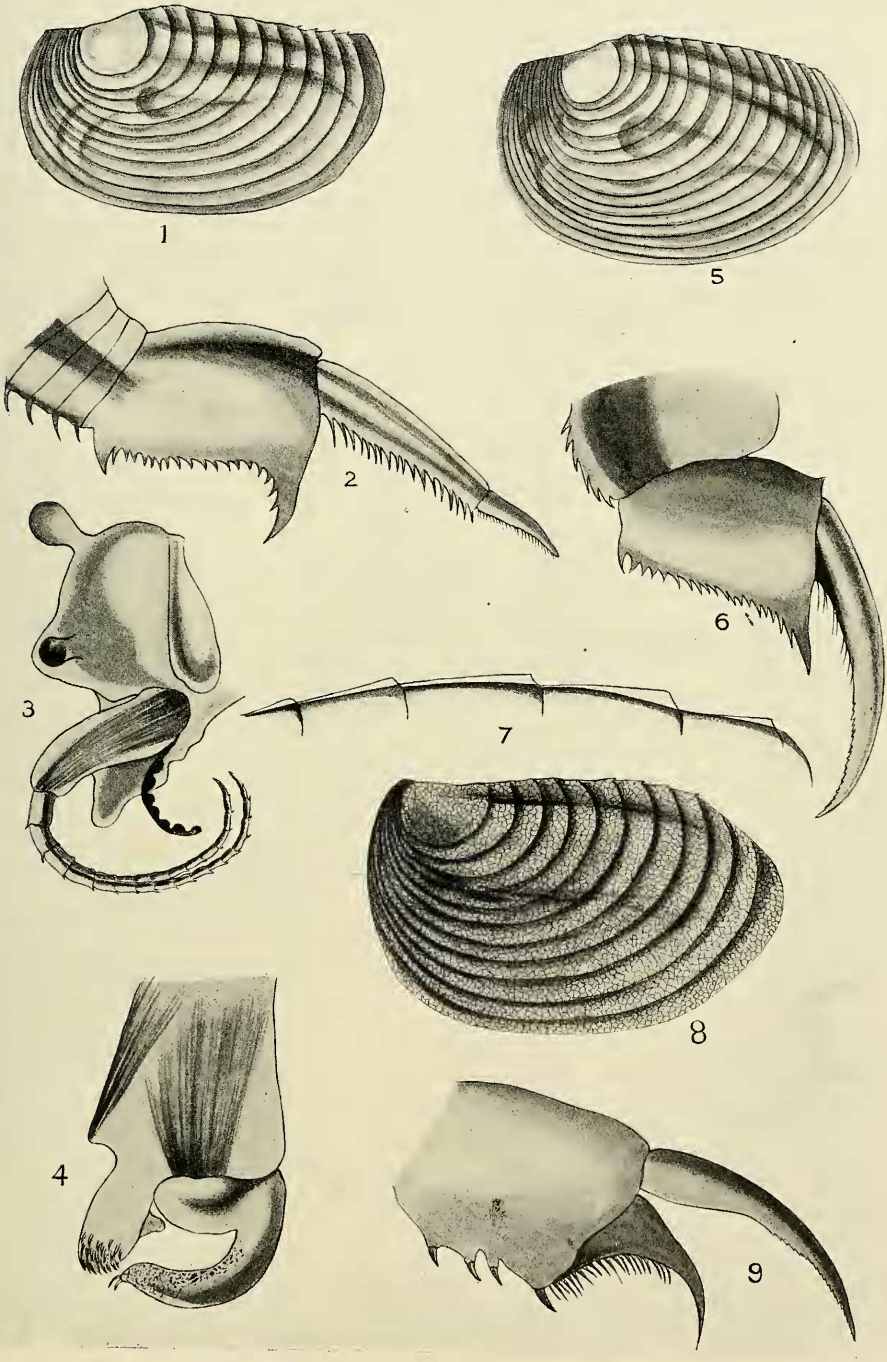
1-4. *Branchinella frondosa* ♀. 5-9. *B. proboscida* ♂.



1-3. *Branchinella proboscida* ♀. 4-7. *Branchinecta tenuis* ♂.



Branchinecta parooensis ♂.



1-7. *Limnadopsis parvispinus.* 8-9. *Estheria rubra.*